

CLAIMS:

1. Method for identification of the parameters of an electro-mechanical system, in particular an electro-mechanical servo system, comprising a mass actuated by a force, said method comprising the steps of:
 - a) applying a constant force to said electro-mechanical system for a predetermined time
 - 5 period, said force having an amplitude at a sub-friction level,
 - b) stopping the mass by applying a negative force,
 - c) iterating steps a) and b) by increasing the amplitude of the constant force applied in step a) in each iteration until the velocity of said mass is monotonously increasing during application of said constant force,
 - 10 d) estimating mass and friction of the electro-mechanical system from the measured movement of the mass,
 - e) performing steps a) and b) at least for another two times by further increasing the amplitude of the constant force applied in step a) wherein the amplitude is increased in each iteration to at most a maximum level at which the electro-mechanical system does not exceed
 - 15 the boundaries of the electro-mechanical system, and
 - f) estimating mass, friction and damping of the electro-mechanical system from the measured movement of the mass.
2. Method as claimed in claim 1, wherein the friction is estimated based on the
- 20 ratio between the time required for acceleration and the time required for stopping the mass.
3. Method as claimed in claim 1, wherein mass, friction and damping are estimated based on a mathematical model of the electro-mechanical system.
- 25 4. Method as claimed in claim 1, wherein the force is applied as a block-wave signal having a constant maximum amplitude in step a).
5. Method as claimed in claim 1, wherein said predetermined time period is in a range from 0.01 to 5 seconds, in particular 0.25 seconds.

6. Method as claimed in claim 1, further comprising the steps of:

a0) applying a force having a monotonously increasing amplitude until the mass starts moving and

5 a1) roughly estimating the friction of the electro-mechanical system and determining the direction of movement of the mass from the measured movement of the mass, which steps are performed prior to step a), in which the initial amplitude of the constant force is set lower, in particular 1 to 25% lower, than the friction estimated in step a1).

10 7. Method as claimed in claim 6, wherein the force is applied as a ramp signal in step a0).

8. Method as claimed in claim 1, wherein the amplitude of the constant force applied in the iterations of step e) is increased by 25% in a first iteration and by 50% in a
15 second iteration.

9. Method as claimed in claim 1, wherein the force is applied as a block-wave signal having a constant maximum amplitude in the iterations of step e), wherein in a first number of iterations, in particular in two first iterations, a force with a positive amplitude and
20 in a second number of iterations, in particular in two subsequent iterations, a force with a negative amplitude, in particular having the same absolute value as said positive amplitude, is applied.

10. Method for autotuning a controller of an electro-mechanical system, in particular an electro-mechanical servo system, comprising a mass actuated by a force, wherein the parameters of said electro-mechanical system are identified by a method as claimed in claim 1, said parameters being used to determine the control parameters of the controller, in particular amplification including its sign, integrator frequency, differentiation frequency and/or low-pass filter settings, such that the electro-mechanical system is operated
30 stable in a low frequency area.

11. Method as claimed in claim 10, wherein said controller comprises a feedback control unit and a feedforward control unit.

12. Method as claimed in claim 10, further comprising a step of optimising the bandwidth of the controller by:

- i) performing a predetermined movement at an initial bandwidth,
- ii) autotuning the controller to obtain an increased bandwidth,
- 5 iii) performing the predetermined movement at the increased bandwidth,
- iv) checking whether said bandwidth increase led to an improvement,
- v) iterating steps ii) to iv) by increasing the bandwidth and performing the predetermined bandwidth until the step of checking in step iv) shows no further improvement.

10 13. Method as claimed in claim 12, wherein the criterion for checking whether the bandwidth increase led to an improvement is based on a root-mean-square error of the difference between the measured movement and the set-point movement, in particular both during movement and during settling.

15 14. Method as claimed in claim 12, wherein the first bandwidth is in the range between 1 and 10 Hz, in particular 5 Hz, and wherein the bandwidth is increased in each iteration by a factor in the range between 1 and 2, in particular $2^{0.25}$.

20 15. Method for controlling an electro-mechanical system, in particular an electro-mechanical servo system, comprising a mass actuated by a force, wherein the parameters of said electro-mechanical system are identified by a method as claimed in claim 1, said parameters being used to determine the control parameters of the controller such that the electro-mechanical system is operated stable by a method for autotuning as claimed in claim 10.

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16. Device for identification of the parameters of an electro-mechanical system, in particular an electro-mechanical servo system, comprising a mass actuated by a force, comprising:

- control means for

- 30 a) applying a constant force to said electro-mechanical system for a predetermined time period, said force having an amplitude at a sub-friction level,
- b) stopping the mass by applying a negative force, and

c) iterating steps a) and b) by increasing the amplitude of the constant force applied in step a) in each iteration until the velocity of said mass is monotonously increasing during application of said constant force,

- sensor means for measuring the movement of the mass, and

- 5 - processing means for initially estimating mass and friction of the electro-mechanical system from the measured movement of the mass, and for finally estimating mass, friction and damping of the electro-mechanical system from the measured movement of the mass after steps a) and b) have been performed at least for another two times by further increasing the amplitude of the constant force applied in step a) wherein the amplitude is increased in each
- 10 iteration to at most a maximum level at which the electro-mechanical system does not exceed the boundaries of the electro-mechanical system.

17. Autotuner for autotuning a controller of an electro-mechanical system, in particular an electro-mechanical servo system, comprising a mass actuated by a force,

15 comprising:

- a device for identification of the parameters of said electro-mechanical system as claimed in claim 16, and

- processing means for determining the control parameters of the controller, in particular amplification including its sign, integrator frequency, differentiator frequency and/or low-

- 20 pass filter settings, such that the electro-mechanical system is operated stable in a low frequency area.

18. Controller for controlling an electro-mechanical system, in particular an electro-mechanical servo system, comprising a mass actuated by a force, comprising:

- 25 - an autotuner as claimed in claim 17 for determining the control parameters of the controller, in particular amplification including its sign, integrator frequency, differentiator frequency and/or low-pass filter settings, such that the electro-mechanical system is operated stable in a low frequency, and

- control means for controlling the electro-mechanical system.

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19. Electro-mechanical system comprising a mass actuated by a force and a controller for controlling the electro-mechanical system as claimed in claim 18.

20. Computer program comprising computer program code for causing a computer to perform the steps of the method as claimed in claim 1, 10 or 15 when said program is run on a computer.